XMM-Newton CCF Release Note

XMM-CCF-REL-290

Implementation of the Variable Boresight for RGS

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July 20, 2012

1 CCF components

Name of CCF	VALDATE	EVALDATE	Blocks changed	XSCS flag
XMM_BORESIGHT_0023	2000-01-01T00:00:00	–	RGS1_ANGVAR RGS2_ANGVAR	NO

2 Changes

Starting in SASv12.0, a variable boresight is being used for the processing of data from the Optical Monitor and the EPIC cameras on-board XMM-Newton [1]. The variable boresight has been implemented in SAS adding new extensions to the CCF XMM_BORESIGHT, one per instrument, holding the values of the variation of the Euler angles as a function of time. XMM_BORESIGHT_0022 is the first version of the CCF having these new extensions for OM and the three EPIC cameras.

We present in this Release Note an extension of this approach to the RGS instruments. Any change in the astrometric solution implies a potential change in the wavelength scale. The main goal of this document is the evaluation of this effect.

3 Scientific Impact of this Update

Talavera et al. [1] have shown that the use of the variable boresight in the processing of EPIC data results in a change in the average offset of the source positions along the spacecraft Z axis (i.e. the RGS dispersion direction) from -0.6 to +0.1 arcsec. This is equivalent to a shift from -1.4 to 0.3 mÅ in RGS first order spectra, half these values in second order spectra. The width of the distribution of the offsets along this axis decreases from 1.5 to 1.2 arcsec (i.e from 3.5 to 2.7 mÅ).

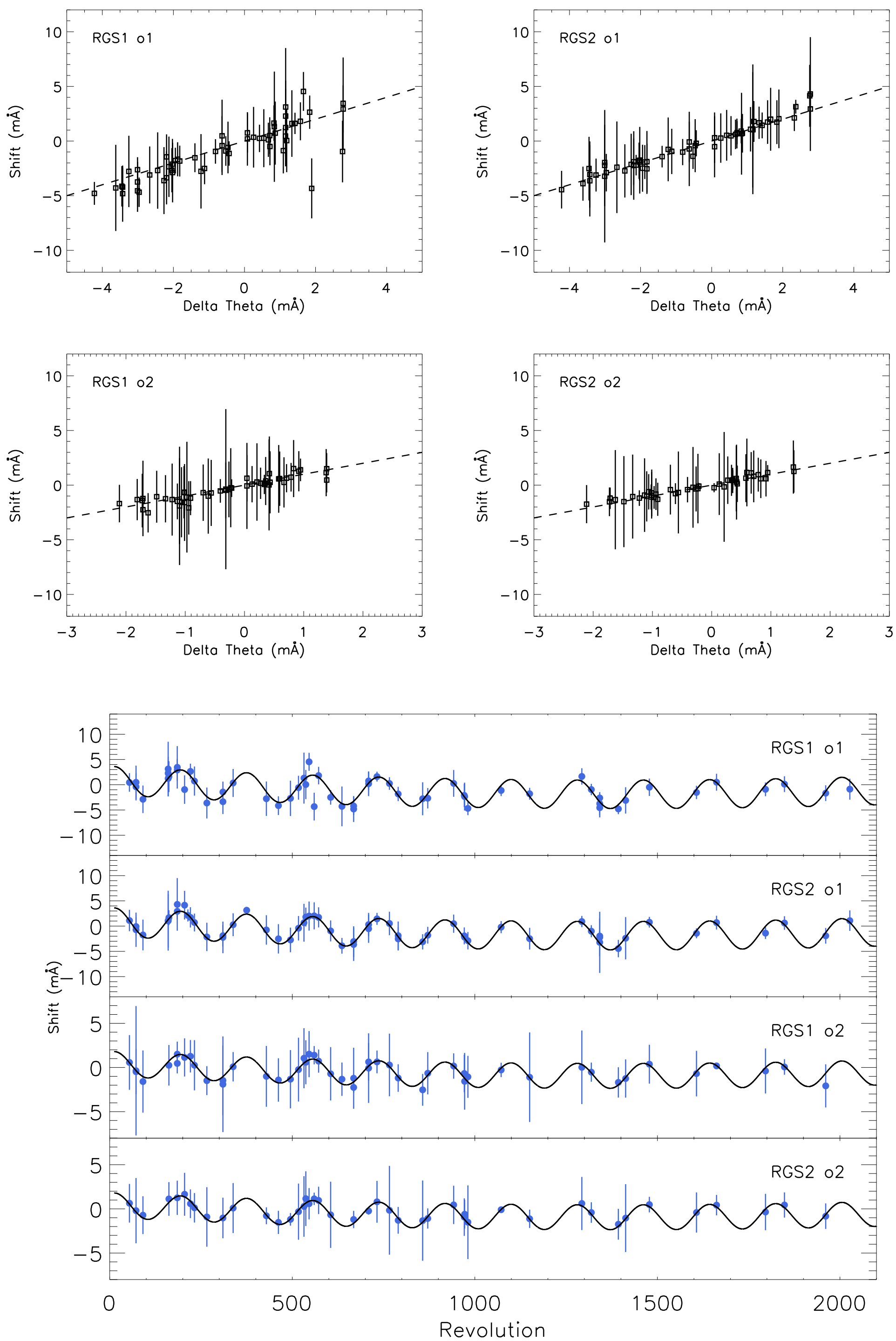

Figure 1: Consistency check: Top: Comparison of the wavelength displacement between the spectra processed with fixed and variable boresight to the corresponding $\Delta\theta$ angle (converted to mÅ) computed from the CCF. The dashed lines correspond to the 1:1 relation. Bottom: Comparison of the displacement between spectra as a function of time (points) to the time dependence of the EPIC ΔZ correction given in [1] (solid line).

To evaluate the effect of the variable boresight on the RGS wavelength scale, we have followed the same reduction and analysis procedures on the same data sample as in [2], but using the new CCF[1] and SASv12.0[2], and we have compared the wavelengths of the emission lines measured in the spectra processed with “Fixed” and “Variable” boresight.

We have first checked that the changes in the line positions are consistent with the correction applied to the boresight.

The top panel of Fig. 1 shows the comparison of the difference in the average wavelength shift per spectrum (converted to arcsec) to the correction in the Euler θ angle for the date of the observation, computed from the values given in the CCF. Dashed lines correspond to the 1:1 relation, and show the overall good agreement.

In the bottom panel we represent again the average wavelength shift per spectrum, but now as a function of time. Overplotted is the parametrisation of the variation of the EPIC shift along the spacecraft Z axis, as given in [1]. The agreement is also good and therefore, the correctness of the implementation of the RGS variable boresight in SASv12.0 is confirmed.

4 Estimated Scientific Quality

The application of the variable boresight leads to average wavelength shifts that are ≤ 1 mÅ smaller than those obtained with the fixed boresight. The scatter of the data is ≈ 1 mÅ smaller as well (see Fig. 2).

The shift between instruments and orders remains the same, not surprisingly, as the correction applied is the same for both RGS and spectral orders.

A similar result is found if, instead of comparing the average shifts per spectrum, we compare the positions of individual lines, as shown if Fig. 3. Shifts are, on average, ≈ 1 mÅ smaller, as it is also the scatter in the data.

5 Expected Updates

The RGS extensions of this CCF should be updated to keep them aligned with the values used for the MOS cameras.

[1] We have used an ’ad-hoc’ CCF, similar to the public XMM_BORESIGHT_0022.CCF, but with two new extensions (RGS1[2]_ANGVAR) in which the values corresponding to MOS1[2] have been replicated.

[2] Release track version xmmsas_20120517_1702-12.0.0-Alpha

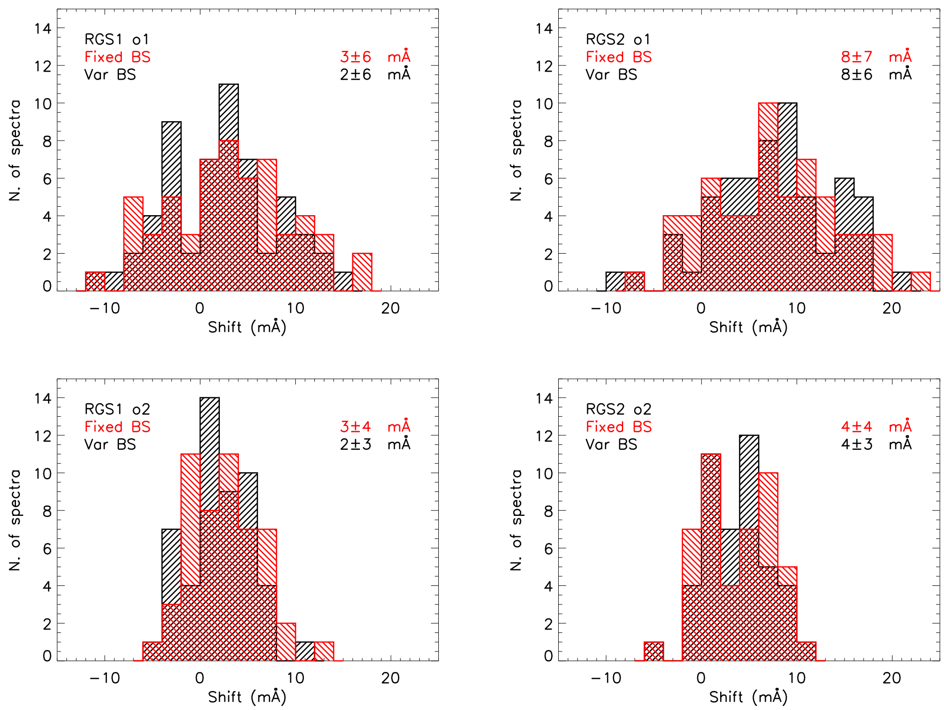

Figure 2: Comparison of the **average spectrum shifts** with respect to laboratory wavelengths measured in spectra processed with fixed and variable boresight.

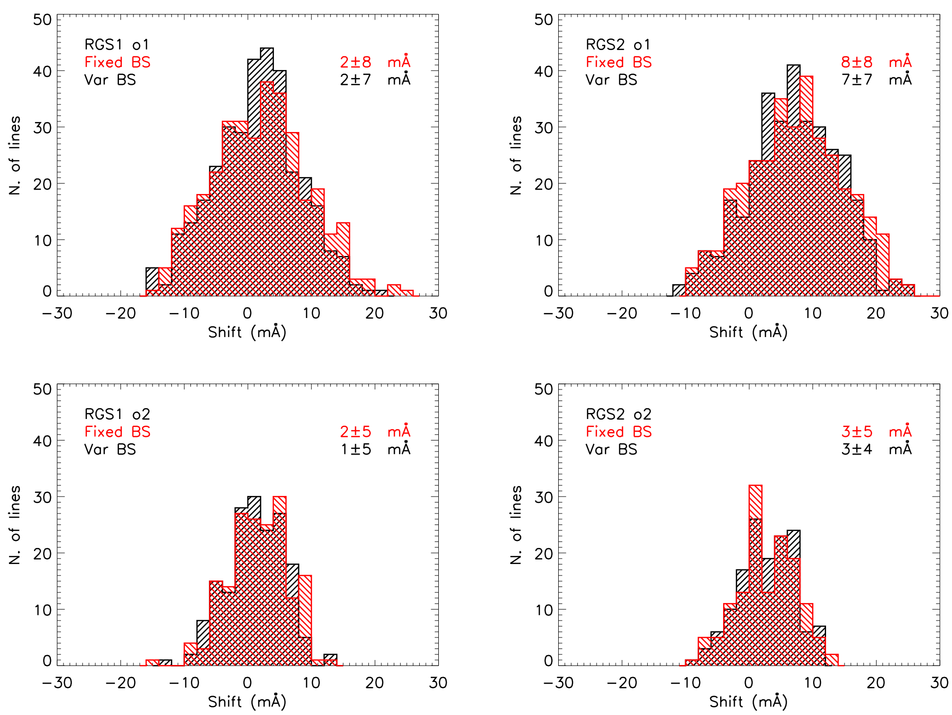

Figure 3: Comparison of **individual line shifts** with respect to laboratory wavelengths measured in data processed with fixed and variable boresight.

6 Test procedures

General checks:

- use `fv` (or another FITS viewer) for file inspection. It should contain six binary extensions.
- use the SAS task `cifbuild` to see if the CAL digests and creates correctly the calibration index file.

7 Summary of the test results

We have confirmed the applicability of the XMM-Newton variable boresight to RGS data. The measured change in the wavelength scale is fully compatible with the applied correction.

The use of the variable boresight results in a marginal improvement in the accuracy of the RGS wavelength scale. Line shifts with respect to laboratory wavelengths are now $\leq$ 1 mÅ smaller. Also, the scatter in the shifts is reduced by approximately 1 mÅ as well.

This improvement is fully consistent with the results obtained for EPIC. The use of the variable boresight in the EPIC cameras makes the average position shift along the spacecraft Z axis to decrease by less than 1 arcsec (2.3 mÅ), and the width of the distribution by 0.5 arcsec (1.2 mÅ). These values are in good agreement with the change in line positions reported here.

References

[1] "Astrometry: time-dependent boresight", A. Talavera, P. Rodríguez-Pascual and M. Guainazzi, XMM-CCF-REL-286, May 2012
http://xmm2.esac.esa.int/docs/documents/CAL-SRN-0286-1-1.pdf.

[2] "The effect of the variable boresight on the RGS Wavelength scale", R. González-Riestra, XMM-SOC-TN-0101, June 2012
http://xmm2.esac.esa.int/ xmmdoc/CoCo/CCB/DOC/Attachments/CAL-TN-0101-0-0.pdf